"Reconsideration on Business Cycles and Environmental Problems"

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1. Introduction

Asia and Latin America are gasping for debt problems and are involved in the monetary crises and environmental problems. Their rapid economic growths have been frustrated by downswings of their Longwaves.(1) In order to restore from the financial crises, they have wanted the merchandise investment for regional integration and the tourism investment to promote the domestic regional economy. But when we consider the deterioration of environmental problems in these areas, we think their economic stimulative measures should not be the same type as they were. On the other hand, in European Union, so-called Ecological Industrial Revolution is advancing in Germany and so forth. It is influencing Latin America, and also Japan and Asian countries. Getting ahead of Germany and Japan, the United States seems to be in the revival process of the Longwave, which has been levered

by financial, information and environmental industries. The United States is advancing not only in finance and information, but also in many spheres of environment.

When we consider the emergency of global environmental problems, the relation between business cycles and environmental problems should be questioned as a new reality of the international economy. I have studied business cycles guided by N.D. Kondratiev and J.A. Schumpeter. When we consider business cycles with environmental problems, the meaning of the critique of modern economics by E.F. Schumacher in his book "Small is Beautiful" becomes clearer and greater. Therefore, I would like to review the preceding studies from the viewpoint of business cycles and environmental problems guided by Schumacher, adding to Kondratiev and Schumpeter.

2. Business Cycles and the Laws of Thermodynamics

N.D. Kondratiev said "We recognize the complexity of the concrete, varying economic activity. But, in the hope of a deeper understanding, we may make reversible or irreversible, processes, or the two together but not combined, a particular topic of research into the theory of dynamics. There is no doubt that, when studying and explaining reversible processes, we must take account of the presence and properties of irreversible processes, and vice-versa. But this in no way affects the need to differentiate between these. When studying the conversion of different forms of energy, the physicist must bear in mind the second law of thermodynamics. However, the mere existence of the principle of entropy does not mean that energy conversion problems do not exist."[2] Not only did Kondratiev compare the difference between reversible and irreversible processes in economic dynamics with two laws of thermodynamics, but also he insisted this differentiation was indispensable to analyze business cycles.[3]

On the other hand, N.Georgescu-Roegen said, "Every subse-

quent development in thermodynamics has added new proof of the bond between the economic process and thermodynamic principles. Extravagant though this thesis may seem prima facie, thermodynamics is largely a physics of economic value, as Carnot unwittingly set it going."(4) Therefore, I have imagined N.D. Kondratiev was an economist who had been conscious of the fact that business cycles were related to the thermodynamic principles. The relation between business cycles and environmental problems should be analyzed in accordance with this fact.

3. The Grounds for Regular Reversible Processes of Business Cycles

J.A. Schumpeter said "Barring very few cases in which difficulties arise, it is possible to count off, historically as well as statistically, six Juglars to a Kondratieff and three Kitchins to a Juglar —not as an average but in every individual case. We shall make use of this fact in our exposition, but the writer is very anxious to make it quite clear, not only that no major result depends on this, but also that no part of his theoretical schema is tied up with it. There is nothing in it to warrant expectation of any such regularity. On the contrary, the logical expectation from the fundamental idea would be irregularity ; for why innovations which differ so much in period of gestation and in the time it takes to absorb them into the system should always produce cycles of respectively somewhat less than 60 years, somewhat less than 10 years, and somewhat less than 40 months, is indeed difficult to see. We state the fact of what seems to us considerable regularity, deviations from which are in every case easily accounted for by external disturbances, because we believe it to be a fact but not on account of any theoretical preconception in its favor."(5)

Schumpeter found reversible processes of business cycles were grounded on innovations. And he said innovations would logically

occur irregularly, but actually they had occurred regularly. Innovations are the new ways to make use of natural resources. Therefore, they are supposed to be the substance of irreversible processes of business cycles and it is difficult to accept them as the substance of reversible processes of business cycles. On the contrary, it is easier to understand the various innovations have been historically repeated by human beings to cope with regular reversible processes of business cycles than to understand they cause the regular reversible processes. But, if innovations could not occur regularly, reversible processes of business cycles would be lost. So, the Metamorphosis Model by G. Mensch[6] would be well grounded. According to the Schumpeter's theory, G. Mensch proved that the basic innovations had occurred discontinuously but regularly, and metamorphosed old industries into new industries. Thereby, he insisted innovations could overcome the depression.[7]

On the other hand, there is another theory for reversible processes of business cycles called the theory of reinvestment cycles that was originated by K. Marx and succeeded by J.M. Keynes.[8] The capital stock adjustment principle that was proposed by R.C.O. Matthews, H.B. Chenery, R.M. Goodwin, etc. criticized the theory of reinvestment cycles but could not exceed it.[9] In the reinvestment cycle theory and the capital stock adjustment principle, reversible processes of business cycles are well expressed with the levels of investment on stock, equipment, construction and infrastructure. Each investment is accumulated and saturated. Innovations need new investment and prevail during the period of renewal of investment in use. So, the reinvestment cycle theory and the capital stock adjustment principle are actually consistent with the innovation theory of Schumpeter.

Even if the substance of reversible processes of business cycles were the level of investment including innovations, this is not enough to explain the regularity of business cycles. Yuji Shimanaka questioned this point and revived the theory of W.S. Jevons who insisted the economic fluctuation were related to the

cycles of sunspots.[10] Y. Shimanaka argued the four cycles of sunspots, those were, short-term, middle-term, long-term, longer-term, caused the four business cycles because the activity of the sun would influence the economic activity of human beings through climate, human psychology, etc. As a matter of fact, solar energy is the large existence for human beings.[11] Therefore, the real substance of regular reversible processes of business cycles would be a phenomenon that the natural business cycles influenced by solar energy are amplified or confused by the introduction of coal energy after the Industrial Revolution, later hydropower generation, petroleum energy, nuclear power generation and natural gas. Consequently, the real substance of irreversible processes would be a phenomenon that the entropy law goes through the cyclical human economic activity.

4. Compound Cycle and Gross Investment Level

Schumpeter made a three-cycle schema of Compound Cycle, which was composed by three sine curves of Kondratiev, Juglar and Kitchin Cycle.[12] He composed three sine curves by proportioning their amplitudes to the periods of cycles, which meant that innovations were classified into large, middle or small one. This classification would be the same as G. Mensch classified innovations into basic, improvement and pseudo innovations.[13] If the level of investment including innovations were the substance of reversible processes of business cycles, we could assume Kondratiev Cycle would be substantially Infrastructure Cycle with the standard period of 60 years. And also, we could assume that Juglar Cycle would be substantially Equipment Cycle with the standard period of 10 years and Kitchin cycle would be Stock Cycle with the standard period of 40 months. These assumptions correspond with the large, middle and small innovations. Moreover, Kuznets Cycle could be assumed to be substantially Construction Cycle with the standard period of 20 years, which would include

larger innovations than Equipment Cycle would include.

Here we should question the content of infrastructure investment. In postwar Japan, the objects of infrastructure investment have been large hydropower plants, petroleum thermal power plants, well paved roads, nationwide highways, electrified railroads, Shinkansen, chemical plants, telephone services, television networks, nuclear power plants, etc. These are related to the basic innovations of the 1920s, 1930s and 1940s mainly in the United States. They are large dam, automobiles, bullet train, computer, television, electronics, petroleum, natural gas, nuclear energy, etc.[14] During the 1990s, they say it is necessary for Japan to invest infrastructures related to finance, information and environment. They are financial systems, Internet communications, optical fiber network, recycle systems of packages, cars and home appliances, etc. It is for the reason that these have been the basic innovations in the United States and Europe in the 1980s and 1990s.

Therefore, these investments for infrastructure are not the same as the public investments. The public investments are actually included in construction, equipment and stock investments. Gross investment includes gross fixed capital formation (construction investment + equipment investment + others) and stock investment. So, the level of gross investment would be composed of the four investment cycles, which were Infrastructure, Construction, Equipment and Stock Cycle. When sine curves are composed, they can express the complexity. According to Schumpeter, we can compose the four cycles by proportioning the amplitudes of sine curves to the periods of cycles. I would like to show you an example of the standard values of amplitudes in the case of Japan (Figure 1).[15] This four-cycle schema could be assumed to be the standard values of the regular reversible processes of Compound Cycle. We can define Compound Cycle as the aggregated four business cycles, which is equal to Longwave. And we can assume that the level of gross investment, that is, an

actual Compound Cycle, Longwave, would circulate by the period of Kondratiev Cycle through the four phases, those are, prosperity (upswing), recession (downswing), depression (stagnation) and revival (recovery) along with the four-cycle schema.

We can find the peaks of Construction, Equipment and Stock Cycle by the ratios of each investment to GDP. The highest peak of Equipment Cycle could be assumed to be the peak of Infrastructure Cycle because basic innovations would be most active around that peak. After we found the peaks of the four cycles, we can adjust the peaks of each sine curve to the real peaks of each investment cycle as possible by changing the start point of the sine curve. Figure 2 shows the cases of Japan and Germany, which compare the levels of gross investment with the four-cycle schemas respectively.[16] Each four-cycle schema is multiplied by the proportion between the amplitude of the real ratios of gross investment to GDP and that of the standard values and after that, added by the average of the real ratios of gross investment to GDP. This is the arithmetical adjustment to compare the level of gross investment with the four-cycle schema directly. The amplitudes of Germany and Japan are very different, but each level of gross investment is fit to each adjusted four-cycle schema and could be forecast to follow the extrapolated four-cycle schema in future.

As I mentioned before, the real substance of regular reversible processes of business cycles must be a phenomenon that the natural cycles of human economic activity influenced by solar energy were amplified and confused by the introduction of fossil fuels, and hydro and nuclear power generations. According to these two figures, it is very effective to assume that the four cycles of investments including innovations would be related to the real substance of regular reversible processes of business cycles.

5. Product Life Cycle and Irreversible Processes of Business Cycles

While the levels of investments including innovations were related to the real substance of reversible processes of business cycles, investment activities including innovations would be related to the one of irreversible processes of business cycles. They would cause new business cycles or confuse the standard business cycles. Business cycles have been more and more amplified because innovations since the Industrial Revolution have introduced nonrenewable fossil fuels and nuclear energy, and have wasted minerals and vegetation without recycle. Since these thirty years, investment activities in accordance with the product life cycle theory and the fiscal and financial policies promoting them have extended innovations internationally. But, they have also produced debt crises in the third world and destructed environment at global scale.[17]

The product life cycle theory explained new products prevailed internationally through the investment activities of multinational companies.[18] New products are typical cases of basic innovations. This theory explained how basic innovations prevailed from the United States to the United Kingdom, Germany or Japan and after that, how they prevailed from these countries to the less developed countries, some of which were called Newly Industrialized Economies (NIES). Therefore, this theory has also explained how environmental problems caused by basic innovations have prevailed globally. Although this theory explained the microprocesses of new products, G. Mensch aggregated micro processes into one macroprocess of the industrialization in these countries.[19] Namely, the domestic investment would increase in the import-substitution process and would transfer to the overseas investment in the export-oriented process after production overcame consumption. On the contrary, the domestic investment would recover in the

re-import process after production fell under consumption. The fiscal and financial policies to promote the investment activities of multinational companies would produce new Compound Cycles, those were, Longwaves in the advanced and less developed countries. According to the aggregated product life cycle, the level of gross investment would be reversible even in the United States, though investment activities including innovations are irreversible.

Concerning the aggregated product life cycle, I would like to show you the levels of gross investment including innovations in the three types of the countries, those were, most advanced, other advanced and less developed countries. (See Figure 3)[20]

Since the 1930s, the most advanced country concerning basic innovations has been the United States.[21] The level of gross investment in the United States has been low since the 1950s and 1960s because the domestic production has been transferred to overseas by the development of multinational companies. And also the private domestic investments were crowded out by the large government debt, which was the result of military research and development expenditure. We can see the domestic investment of the United States had recovered temporally during the 1970s partly because the domestic production fell under the domestic consumption and the re-imports increased and partly because the government debt balance improved very much. In the 1980s, the level of gross investment declined mainly because new industries had not yet grown. The economic stimulative measures deteriorated the government debt balance again. But, since the early 1990s, it began to recover, because a new Compound Cycle, that was, a new Longwave, was levered by the new industries of finance, information and environment. As the level of government debt balance would indicate the opposite level of gross investment, its negative sign would indicate Longwave.[22] (See Figure 4)[23] The ratios of government debt balance to GDP in the United States has recovered in the middle 1990s, which also would suggest Longwave reviving.

The levels of gross investment in the less advanced countries like Germany and Japan had been on the upswing of Longwave during the 1950s and 1960s because the both countries were in the import-substitution process. But they had been on the downswing of Longwave since the late 1970s mainly because the both countries entered in the export-oriented process. In the late 1980s, they had recovered temporally mainly because the both countries were in the re-import process. In the 1990s, it has been on the stagnation mainly because new industries have not yet grown. The economic stimulative measures have deteriorated the government debt balance. These phases are following those of the United States about ten years later. Since the last thirty years, the similar industrial policies of Germany and Japan have been to promote the exports of cars, home appliances, electronics and industrial machines, etc., and to enlarge nuclear power generation. These policies also have deteriorated the environmental problems in Germany as well as those in Japan.

In Germany, the recycles of packages, cars and home appliances, the regulation of dioxin, the withdrawal from nuclear power generation, etc. have been taken up as the basic innovations for the next generation. In Japan, it is very late to take up the recycles of them and the regulation of dioxin. On the other hand, Japan has been planning to use plutonium by recycling nuclear waste. But plutonium recycle is very expensive and risky, which would be very weak to produce a new Longwave.[24]

The levels of gross investment in the less developed countries like Korea and Indonesia had been on the upswing of Longwave since the 1950s and 1960s when the investment from the United States and Japan produced new Longwaves in this area. But, in the 1990s, they have turned to the downswing of Longwave mainly because the import-substitution processes terminated. Their patterns are very similar to the Japanese pattern of twenty years ago. In order to cope with the downswings of Longwaves in the late 1990s, the both countries are promoting the exports of cars,

electronics and other machines and the introduction of nuclear power generation as well as Japan promoted and enlarged twenty years ago.

The three patterns of the levels of gross investment in the three types of countries indicate the existence of the aggregated product life cycle. Technology transfer made the environmental problems prevail internationally at the same time. They are the evidences for irreversible processes of business cycles. But they are also the evidences for reversible processes, which are repeated internationally. Therefore, NIES countries have to know that the main theses of the environmental problems in Germany or Japan are the results of basic innovations like cars, home appliances, electronics, nuclear power generation, etc., which were introduced from the United States during the postwar period. And it is necessary for them to introduce quickly so-called Ecological Industrial Revolution in advance.

6. Longwave and Ecological Industrial Revolution

Although E.F. Schumacher sounded many warnings, the investment activities of multinational companies and the development aids which have been centered on goods and money, not on knowledge and education, have made the traditional types of innovations prevail and amplified business cycles. They have accelerated the irreversible processes and deteriorated the global environment. E.F. Schumacher insisted human beings and their environment, not goods or services, should be the first priority in innovations and investment activities. His critique on modern economics is increasing the significance more and more.

Schumacher said in the beginning of his book, 'Small is Beautiful', "One of the most fateful errors of our age is the belief that 'the problem of production' has been solved. Not only is this belief firmly held by people remote from production and therefore professionally unacquainted with the facts—it is held by virtually

all the experts, the captains of industry, the economic managers in the governments of the world, the academic and not-so-academic journalists. They may disagree on many things but the problem of production has been solved ; that mankind has at last come of age. For the rich countries, they say, the most important task now is 'education for leisure' and, for the poor countries, the 'transfer of technology'."[25] The understanding of environmental problems by Schumacher was very comprehensive. He pointed out "This illusion, I suggested, is mainly due to our inability to recognize that the modern industrial system, with all its intellectual sophistication, consumes the very basis on which it has been erected. To use the language of the economists, it lives on irreplaceable capital which it cheerfully treats as income. I specified three categories of such capital : fossil fuels, the tolerance margins of nature, and the human substance."[26] Therefore, I would like to define so-called Ecological Industrial Revolution as human beings conserving these three kinds of natural capital.[27]

Amory B. Lovins who was inspired by the thought of E.F. Schumacher advocated the conception of soft energy paths in 1976.[28] Lovins insisted energy sources should be transferred from hard energy (fossil fuels and nuclear power) to soft energy (energy conservation and renewable energy) in order to stop nuclear proliferation.[29] This conception influenced the energy policy of U. S. President Jimmy Carter, who banned civil reprocessing of nuclear waste indefinitely in 1977.[30] And by the Public Utilities Regulatory Policy Act of 1978, renewable energy and co-generation were given preference measures and the public utilities were obliged to buy them, which were the strong energy incentives. Lovins applied thermodynamics to the energy problems of the United States and suggested changing hard energy paths, which would invade the tolerance margins of nature. He concluded, "We would still be wise to use our remaining cheap fossil fuels to finance a transition as nearly as possible straight to our ultimate

energy income sources."[31]

This conception is contrary to the introduction of fossil fuels and nuclear energy after the Industrial Revolution. Therefore, we can consider Ecological Industrial Revolution in the United States began at that time. At the same time, Dr. S.L.Fawcett, the President of Battelle Memorial Institute, said "It is the last ten years since we have recognized there is nothing to be free in the future evolution to utilize the globe. There are no more free air or water, energy or land, etc. Any system to produce materials, products and services for humankind to utilize must be a closed one. Input and output should be basically the same, or at least inert and no intrusive into environment. In the second Industrial Revolution we are now rushing in, enterprises should be going economically to optimize their behaviors on the basic rule of a new game."[32]

In the United States, energy incentives to soft energy,[33] wind power generation,[34] organic agriculture,[35] green building,[36] biological regionalism,[37] ecological city planning,[38] etc. have prevailed at the local governments and grass roots. The concept of environmental accounting[39] has penetrated into the multinational companies. These economic activities are the basic innovations that have levered to produce a new Longwave in the United States during the early 1990s. But, on the other hand, the old types of innovations like gene combination crops are growing.[40] The use of gene combination will spend the fund of natural capital and invade the tolerance margins of nature as well as the use of fossil fuels and nuclear energy did.

In the postwar, Germany as well as Japan has introduced innovations from the United States. In Germany, a nuclear waste reprocessing facility under construction was abandoned in 1989 and the development of a fast breeder reactor was stopped in 1991. Germany has accelerated the development of soft energy and followed Ecological Industrial Revolution of the United States.[41] The German social systems for the recycles of packages, cars,

electronics have been appreciated as advanced.[42] Environmental inspection of business activities,[43] fuel cell, wind power generation, escape from nuclear power generation, organic agriculture, green building, natural paint, etc. have pervaded Germany. These economic activities will reduce fossil fuel consumption and encourage the business activities that do not exceed the tolerance margins of nature. And they will restore the humanity in production and consumption.

7. Conclusion

The nuclear waste reprocessing plant in Japan began full operation in 1981 when U.S. President Ronald Reagan lifted the ban on commercial reprocessing in the United States, but the Japanese prototype of the fast breeder reactor, Monju, went critical in 1994 and the plutonium recycle project suspended in Japan. New Energy and Industrial Technology Development Organization (NEDO) was established in 1980, immediately after the second oil crisis, as a semi-governmental organization.[44] In Japan, Ecological Industrial Revolution has begun under the pressure from overseas, but it is obviously behind the one in Germany. On the contrary, Japan is criticized as crazy by the foreign ecologists because the quantity of dioxin emission in Japan is estimated to occupy over 50% of the world. The Japanese urgent targets of economic stimulative measures should be not only the financial big bang and the internet services, but also the innovations of Ecological Industrial Revolution, which could produce a new Longwave according to the aggregated product life cycle.

Nowadays, the use of natural gas is expanding all over the world, not excepting Japan. If co-generation and fuel cell prevailed, natural gas would substitute nuclear energy and petroleum. But, by the leverage of natural gas, it is necessary to pursuit soft energy paths, which could enlarge employment because

labor intensive works would be stimulated. The solutions of environmental problems are to diminish the use of fossil fuels and nuclear energy, which has been increasing since the Industrial Revolution and to decrease the amplitudes of business cycles. They will be able to create the stable economy liberating from over capacity or over production and to restore the humanity lost in the bubble economy. Only the restoration of humanity can conserve the quality of soil and water and revive the life style without the anxieties of hazardous chemical substances, endocrine disrupters, radioactivity, nuclear explosion, etc. All of these measures are necessary to solve environmental problems. Thirty years ago, E.F. Schumacher called to realize these kinds of measures to cope with economic and environmental problems. There is no other ways for human beings except to accept his critique of modern economics and his philosophy of "Small is Beautiful".

End

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(1) "Kondratieff gave two possible explanations for these cycles. The first was that businesses tend to over-invest by the top of the longwave and thus being drain of resources, must wait until the bottom of the longwave until more resources could be accumulated for further investments. The second explanation was that there were more innovations in the market place at certain phases of the longwave, which brings about economic prosperity. When innovations decline, so does the economy." The Longwave and Social Cycles Resource Centre, http : //web.1-888.com/longwave/

(2) Nikolai Dmitrievich Kondratiev "The Concept of Economic Statics, Dynamics and Conjuncture," 1924, The Works of Nikolai D. Kondratiev, Volume 1, published by Pickering & Chatto Publishers Limited, 1998, p.14.

(3) N.D. Kondratiev, ibid. p.23

(4) Nicholas Georgescu-Roegen, "The Entropy Law and the Economic Process," Harvard University Press, 1971, p.276.

(5) Joseph A. Schumpeter "Business Cycles, A Theoretical, Historical, and Statistical Analysis of the Capitalist Process," First edition 1939, Abridged edition 1964, Procupine Press, pp.149-150.

(6) "We have abandoned the notion that the economy has developed in waves in favor of the theory that it has evolved through a series of intermittent innovative impulses that take the form of successive S-shaped cycles. The cycle that I think we are currently passing through, which is pictured as S-shaped curve, fits perfectly into this schema, which I call the metamorphosis model depicting long periods of growth and relatively short intervals of turbulence." Gerhard Mensch "Stalemate in Technology, Innovations overcome the Depression," Ballinger Publishing Company, Cambridge, Massachusetts, a subsidiary of Harper & Row Publishers Inc. English language edition, 1979, p.73.

(7) "We can now pursue the question of how the fluctuations in the frequency of basic innovations fit into the overall economic dynamic that we have demonstrated with the aid of metamorphosis model. The alternation between stagnation and innovation allows us to surmise that surges of basic innovations will come during the periods when stagnation is most pressing, that is, in times of depression. The basic innovations put an end to investor's pessimism and their wait and see attitude. The technological stalemate, the pause for adjustment during the economic growth process, is overcome by a surge of innovations that provides new frontiers to enrich the economy. In this way the economy can recover from a crisis." Gerhard Mensch, ibid. p.131

(8) Yuji Shimanaka "Solar Activities and Business Cycles," Nihonkeizai Shinbunsha, 1987, p.52.

(9) The capital stock adjustment principle is defined that investment activity is the process to adjust actual capital stock to optimum capital stock. See The Dictionary of Economics by Toyokeizai Shinposha, 1984, p.330, Miyohei Shinohara has explained the relation between capital stock adjustment principle and business cycles. See Miyohei Shinohara "Long term dynamics of the world economy," TBS Britannica, 1991, p.35. This explanation is the same as K. Marx and D.H. Robertson defined cyclical crises as reinvestment cycles. See Yuji Shimanaka, ibid. p.51.

(10) Yuji Shimanaka "Revival of the sunspots theory of economic fluctuation," Business and Cycle (The journal of the Japanese academic association of Business Cycles), No.1, 1986.

(11) "The school of the Physiocrats believes that there is an immutable natural order behind both physical and social world phenomena *(l'*

ordre naturel) and strives to identify those constant connections and dependences between the elements of socio-economic activity that are intrinsic to this natural order." N.D. Kondratiev, ibid. p.2 I think this natural order would be created by the influence of solar energy.

(12) Yuji Shimanaka "Compound Cycle," Toyokeizai Shinposha, 1995, p.4.

(13) "Technological basic innovations produce new markets and industrial branches whereas nontechnical basic innovations open new realms of activity in the cultural sphere, in public administration, and in social services." G. Mensch, ibid. p.47. "Further development in established areas of activity which were once established by a basic innovation is what I call improvement innovations. Improvement innovations account for the linear extensions of the branches on the evolution tree." ibid. p.47. "However, the economic situation tends to become critical if the impetus from prior basic innovations peters out and more pseudo-innovations are substituted for real improvement innovations. Then in a stalemate in technology, the propensity for basic innovations increases." G. Mensch, ibid. p.48.

(14) G. Mensch, ibid. See Table 4-4, pp.127-128.

(15) See, Osamu Ozeki "Reconsideration on Present Phases of Business Cycles Comparing Mexico, South Korea and Japan," The Yokohama Shodai Ronshu (The Journal of Yokohama College of Commerce), Vol.32, No2, March 1999, 159.

(16) See, Osamu Ozeki, ibid. p.160

(17) Susan George "The Debt Boomerang, How Third World Debt Harms Us All," Pluto Press, 1992, pp.1-33. "This book examines six major 'Debt Connections' ; six ways in which the third world 'Debt Boomerang' strikes the North as it flies back from the South : 1. Environmental Destruction, 2. Drugs, 3. Costs to Taxpayers, 4. Lost Jobs and Markets, 5. Immigration Pressures, 6. Heightened Conflict and Wars." ibid. p.vii. Susan George proved the product life cycle from the United States to the third world boomeranged from the third world to the advanced countries.

(18) Raymond Vernon "International Investment and International Trade," The Quarterly Journal of Economics, 1966, p.199.

(19) "The empirical gaps in the fund of knowledge available to economists are matched by the methodological weaknesses in an attempt to aggregate microprocesses into one macroprocess. The mathematical difficulties are comparable to those encountered by Einstein in his struggle to integrate partial difference equations into his general description of relativity theory." G. Mensch, ibid. p.69.

(20) See, Osamu Ozeki, ibid. p.144

(21) G. Mensch, ibid. See Table 4-4, pp.127-128.
(22) The government debt would be crowding out the private investment during downswing or stagnation period of Compound Cycle. See 'Crowding-out effect' in the Dictionary of Toyokeizai Shinposha, 1984, p.668.
(23) See, Osamu Ozeki, ibid. p.166
(24) Charles B. Reed "Fuels, Minerals and Human Survival," Ann Arbor Science Publishers Inc., 1975, pp.29-36.
(25) Ernst Friedrich Schumacher "Small is Beautiful, A Study of Economics as if People Mattered," originally published by Blond & Briggs Ltd., London, in 1973, Harper & Row, Publishers, New York, 1989, p.13.
(26) E.F. Schumacher, ibid. p.21
(27) "The cornerstone of the next economy will be radically improved resource productivity. 'Natural capitalism' redesigns industry on ecological principles, with closed loops and zero waste. It shifts the economy from the episodic acquisition of goods to the continuous flow of value and service. And it reinvests in restoring, sustaining and expanding the stock of natural capital." Natural Capitalism, The Greening of Business, taught by Amory Lovins, Ernst von Weizsaecker, John Elkington, June 1999, in Schumacher College, Dartington Hall, U.K. http : //www. gn. apc. org/schumachercollege/ both. htm
(28) The paper "Energy Strategy : The road Not taken," was published in Foreign Affairs, October 1976.
(29) "At the end of his term, President Gerald Ford publicly announced that the United States would stop reprocessing spent fuel and would not export enrichment or reprocessing technology. — The result of congressional concerns over proliferation of nuclear weapons materials and the Carter administration policies in the United States was passage of the Nuclear Non-Proliferation Act in 1978." The International Nuclear Fuel Cycle sponsored by Washington Nuclear Corporation, "U.S. Nuclear Non- Proliferation Act" http : //axil. whatswhat. com/nuke/html/us-nnpa. hyml
(30) "When President Ronald Reagan lifted the ban on commercial reprocessing in 1981, the private sector did not respond." The International Nuclear Fuel Cycle sponsored by Washington Nuclear Corporation "Reprocessing, the United States," http : //www. nuke-energy. com/html/reproc-us. html, 1998/06/09. "The Reagan Administration's nuclear energy policy was dealt a severe blow when the Senate cut all funding for Clinch River breeder reactor on October 26, 1983." The United States Department of Energy, a

summary History,1977-1994, part 5, http : //www. doe. gov/html/doe/about/history/doehist. html

(31) Amory B. Lovins "Soft Energy Paths, Toward a Durable Peace," Friends of Earth International, 1977, p.60.

(32) Sherwood L. Fawcett "Comments from the President," The President's Report & Annual Review, Battelle Memorial Institute, 1977, pp.2-3.

(33) "A juxtaposition of foreign incentives types with those of the United States provides information on incentives not being used by the United States and a better understanding of energy incentives in general. This additional information can be used to assist the Office of Conservation and Solar Applications, U.S. Department of Energy, in the study and recommendation of federal incentives for the development of solar energy in the United States." J.C. Emery, O. Ozeki, etc. "An analysis of Japanese incentives used to stimulate energy production, An Executive Summary," prepared for Division of Conservation and Solar Applications, Department of Energy by Battelle, Pacific Northwest Laboratory, Richland, Washington, 1979, p.1.

(34) "The U.S. wind industry currently generates about 3.5 billion kilowatt-hours of electricity each year--enough to meet the annual electricity needs of 1 million people." National Wind Technology Center operated National Renewable Energy Laboratory of U.S. Department of Energy, August 2, 1999, http : //www. nrel. gov/wind/marketplace. html

(35) "USDA Organic Food Regulations : This proposed, which was published in the Federal Register on December 16, 1997, will enact provisions of the Organic Foods Production Act of 1990 which requires the establishment of national standards governing the marketing of organically produced agricultural products" U.S. Senator Joe Lieberman, New for July/August 1999, http : //www. senate. gov/member/ct/lieberman/general/food. html

(36) "Going Green : Changing the Way We Build, will examine how we have created the human-built environment in which we live today," Smart Office Resource Center, March 4, 1998, http : //www. smartoffice. com/Green Building. htm

(37) "Bioregionalism : The Quiet Revolution Out There, it doesn't make news because it's neither a disaster nor a feat (like a space shot), but there's something very quietly exciting going on across this continent." Ann Kingsolver, New Alchemy Quarterly, Fall 1984, No17, http : //www. fuzzylu. com/greecenter/q17/bioreg. htm

(38) "In 1996, at the inauguration of the U.S. Presidential Awards for

Sustainable Development, Chattanooga was chosen as the first city to receive the award." The Chattanooga Institute, 1999/08/07, http : //www. cs2. org/page7. html

(39) "In less than five years, accounting for the environment has moved from being considered a marginal topic, to having an increasingly central role in the deliberations of the international accounting profession." Roger Debrecency, "Accounting for the environment," Dec 3, 1996, http : //status. shh. fi/anet/lists/abboks-1/0201. html

(40) Jeremy Rifkin "Algeny," Foundation on Economic trends, 1983, Translated by Hitoshi Takeuchi, Japanese Copyright by Shodensha Co. Ltd.

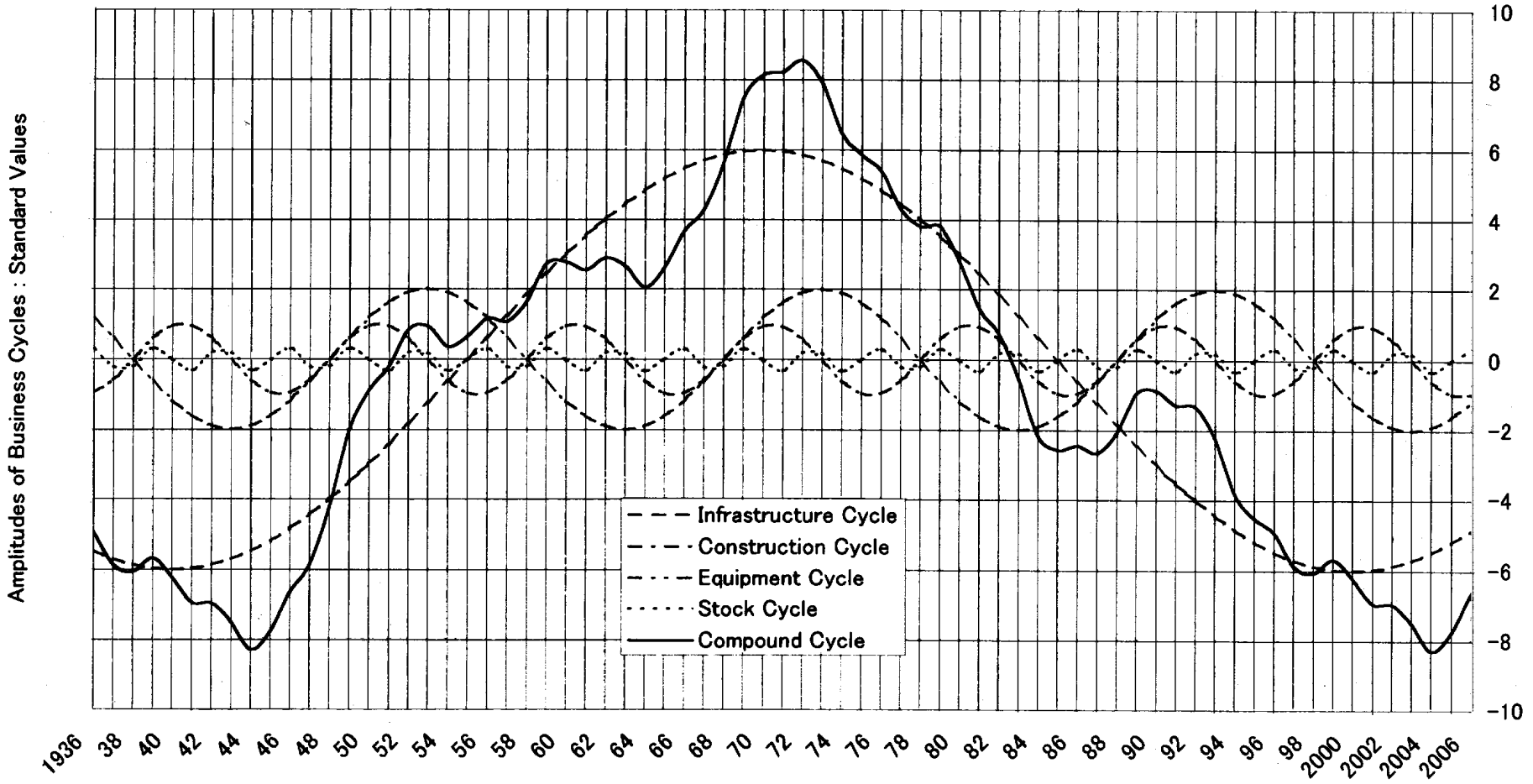
(41) Ecological Industrial Revolution in the advanced countries has become a hazard to the less developed countries. IPS news reports, World News "Environment : MERCOSUR a Toxic Waste Dump ?," Montevideo, Feb 1, 1998, http : //www. oneworld. org/ips2/feb98/ toxicwaste. html

(42) Siemens "Harmonizing economy and ecology," Private Communication Systems Group of Siemens AG, Munich, 1995, http : //www. siemens. de/telcom/articles/e0195/195schm. htm

(43) Christpher Sheldon "ISO 14001 and Beyond," Greenleaf Publishing Broom Hall, 1997, http : //www. isoeasy. org/iso14001. htm

(44) "NEDO's activities include such fields as development and promotion of new energy and energy conservation technologies, research and development of industrial technologies, restructuring of Japan's domestic coal mining industry, production of industrial alcohol and restoring damaged coal mining area." NEDO Home, 1999.8.10, http : //www. nedo. go. jp/english/home. html

Figure1. Business Cycles composed by Sine Curves : In the case of Japan



Infrastructure Cycle=6sin(360n/60), Construction Cycle=2sin(360(n+7)/20),
Equipment Cycle=1sin(360(n−3)/10), Stock Cycle=0. 333sin(360n/3. 33)
Compound Cycle=Infrastructure+Construction+Equipment+Stock Cycle

Figure2. Compound Cycle in Japan and Germany indicated by Four-cycld Schema

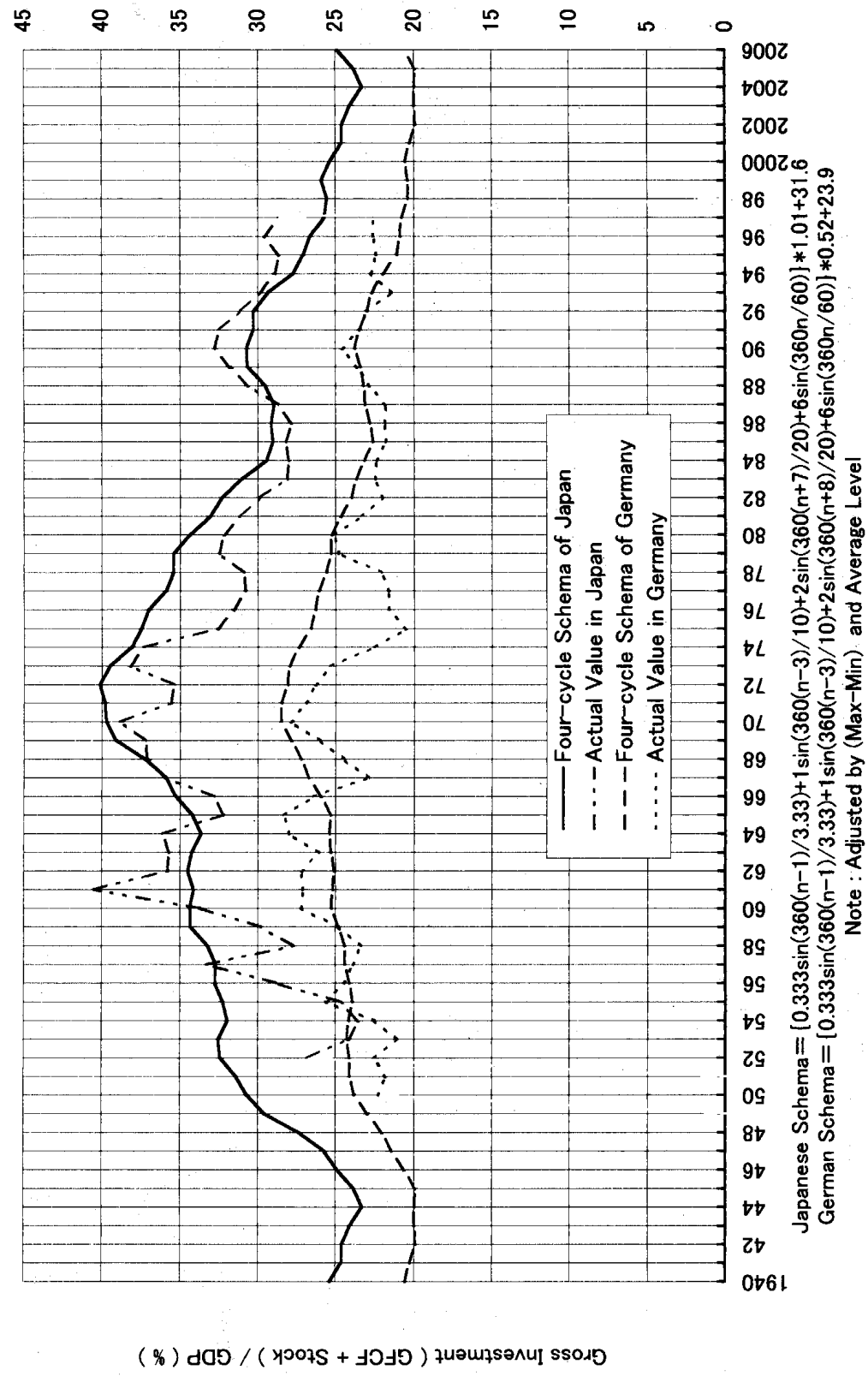


Figure3. Aggregated Product Life Cycle indicated by Gross Investment Level : U.S., Japan, Korea, Indonesia

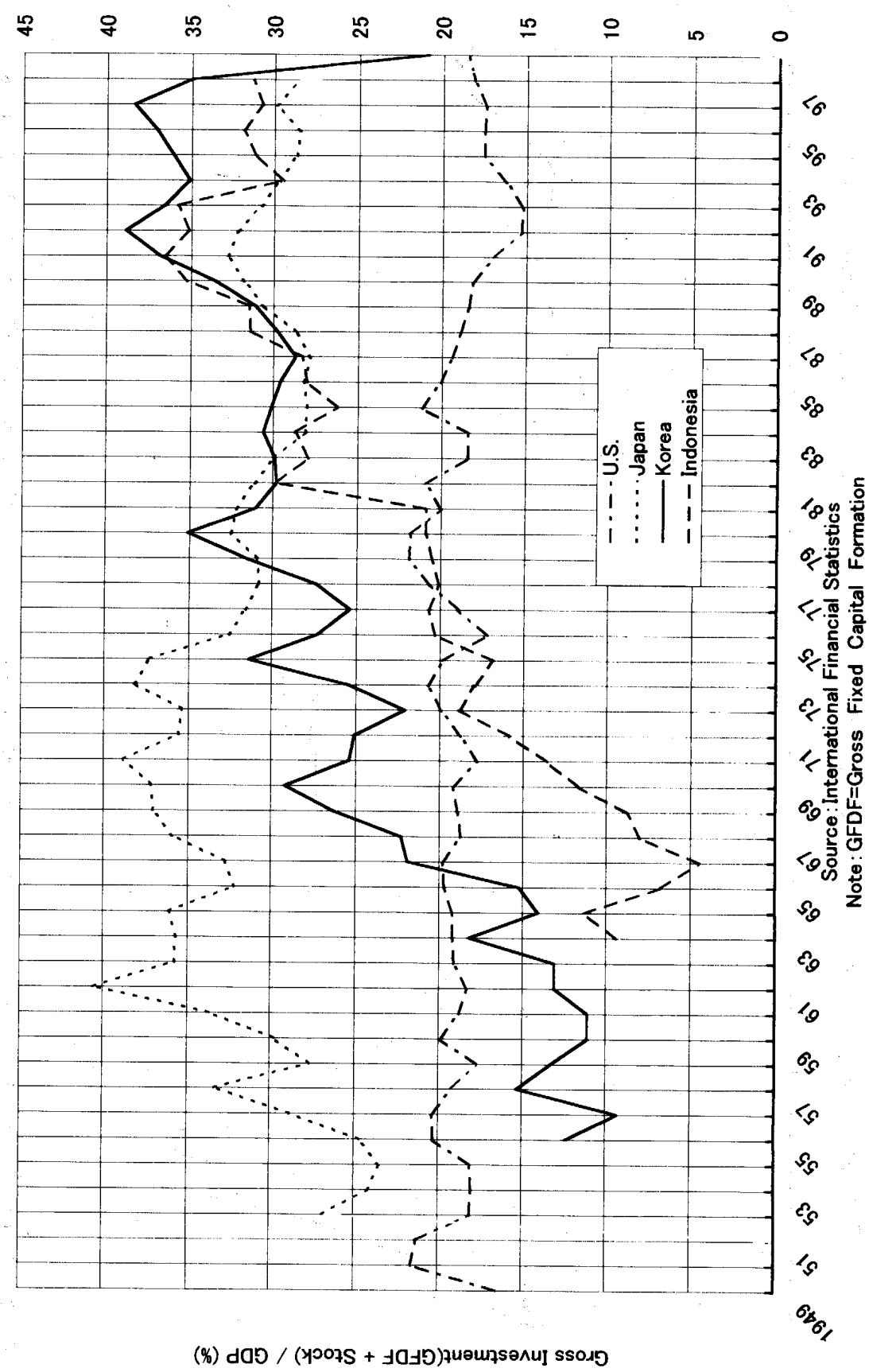
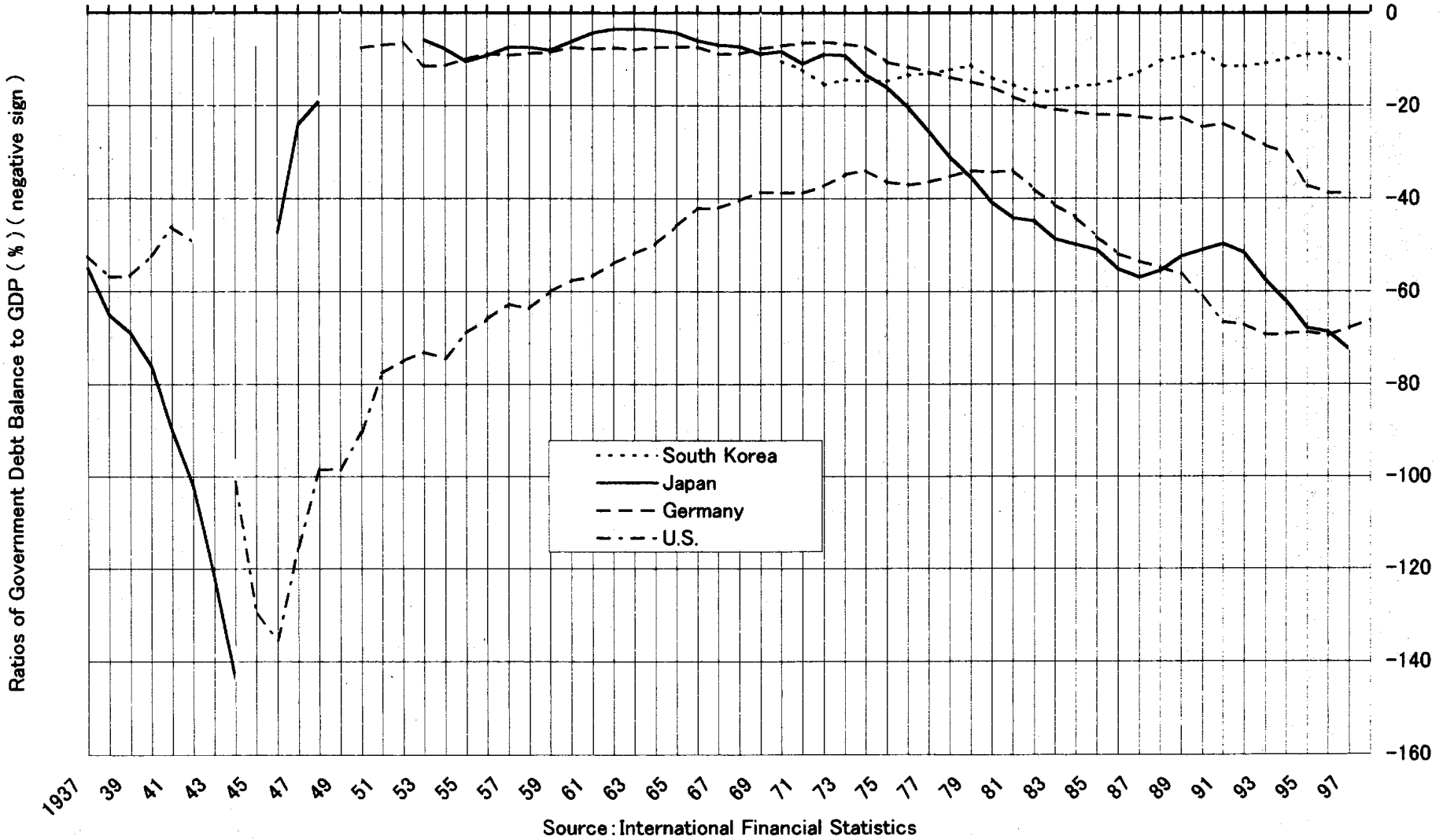


Figure4. Longwave indicated by Government Debt Balance : South Korea, Germany, U.S.



Source : International Financial Statistics